

INFORMATION REPORT INFORMATION REPORT

CENTRAL INTELLIGENCE AGENCY

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COUNTRY	USSR	REPORT	
SUBJECT	Description of an Advanced Version of the Mig 21/Physical Characteristics/Calculation of Performance/Analysis of Components/Performance Capability/Charts and Legends	DATE DISTR.	19 Feb 59 25X1
		NO. PAGES	5
		REFERENCES	
DATE OF INFO.			25X1
PLACE & DATE ACQ.			

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Introduction

1. Whereas the prototype of Mig-21 had been demonstrated in June 1956 at Tushino Airport, the present and substantially improved version (Faceplate) probably did not go into series production until October 1957. The fact that a number of fighter squadrons within Istrebitel'naya Aviatsiya Protivovozdushnoy Odborony (IAPVO), i.e. Soviet Fighter Command of Anti-aircraft Defense, have been supplied with Mig-21, points to the production capacity of the Soviet aviation industry. The Soviet satellites have been supplied with Faceplate.

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The East German Air Force is retraining her pilots to Mig-21.

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Aerodynamic Considerations

2. The new version of Mig-21 is somewhat similar in aerodynamic formula to the Mig-19; nevertheless, the performance improvements are considerable. Faceplate is the first Soviet fighter to break Mach 2. In this respect it parallels Western developments. The sweepback of the wing leading edge is extremely high (57°), resembling the Mig-19 and English Electric P-1, and the resistance behavior in breaking through the sound barrier is highly favorable. However, a pronounced sweepback entails an unpleasant sweep effect, thus causing certain less agreeable flying properties during the flight at low speeds. Thus, the employability of Mig-21 as a ground support weapon is limited to a considerable extent.

Comparison with the Supertiger

3. The profile thickness of a geometrically untwisted wing varies between 6% at the root and 4% outwards, and is approximately symmetrical. The boundary layer fences, extending up to the leading edge of profile, permit the assumption that Mig-21 is not equipped with leading-edge flaps. The ailerons are designed in conventional manner. It follows that the high-lift devices of

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Faceplate produce a considerably lower maximum lift than those of Supertiger. Therefore, the Soviet designers were able to contain the takeoff and landing runs within the useful limits only by detouring over the lower wing loadings; clearly this condition reduces the maximum speed. In most cases, the effect of a low wing loading on the absolute ceiling attainable by the transonic aircraft is evaluated incorrectly. Of course, the subsonic absolute ceiling will exceed that of an aircraft type with a higher wing loading; however, the transonic absolute ceiling determines the degree of employability. It becomes obvious, in scrutinizing the transonic absolute ceilings that the relationship between the lifting power and the resistance constitutes the lift-to-drag ratio, and is therefore of decisive importance. An aircraft achieves its stationary absolute ceiling when the thrust excess is equal to zero. However, the thrust excess depends on the resistance of aircraft. Nevertheless, the example of F-104 which, as we know, possesses an absolute ceiling of approximately 25 km, demonstrates clearly the possibility of obtaining extremely high lifting values at low resistance, with a small wing surface, correspondingly high loadings, moderate sweep of the leading edge, and Mach numbers in the environs of 2, at very high altitudes. In this respect, the resistance constitutes the determining factor. However, the resistance is very high with Mig-21, and the aerodynamic formula does not merit a great deal of approval, inasmuch as the flight performance is enforced, in substance, by a high-thrust engine.

4. Calculation of performance shows that the absolute ceiling without a rocket engine is lower by 2 km than that of Western competitors; and the high surface resistance in the speed area exceeding Mach 2 is also responsible for the fact that the maximum speed remains limited to Mach 2.25 in spite of the high thrust.
5. The slenderness ratio of fuselage is more favorable than with Mig-19 and comparable with Supertiger. This ratio of slenderness combined with the low thrust load, causes the increment of maximum speed.

Influence of Fuselage Design

6. The gradient of nose contour plays a very important role, because the wave resistance increases approximately in square with the climb. The nose contour of Mig-21 is designed in good conformance with the conditions of visibility and cockpit length, and does not yield in this respect to the corresponding solution in Supertiger.
7. The middle section of fuselage is cylindrical, and has an elliptic cross section. Obviously, this configuration contributes to maintaining the construction costs within tolerable limits, while the fuel capacity is even higher than with the spindle fuselage of comparable length.
8. The ventral tunnel below the tail section contains a liquid-fuel rocket engine with a thrust of 2,000 kg/hr, and a burning rate of 80-90 sec. The principal purpose of this engine consists probably of raising the absolute ceiling by approximately 3 km for a short period of time.
9. The climb performance can be improved to a very substantial degree, and at any altitude by this additional power source; however, the rocket engine whose thrust remains constant or even increases slightly with the altitude, becomes economical only at altitudes exceeding 11 km.
10. The maximum speed is affected by the additional thrust of the rocket engine to a far lesser extent than accelerations and climb performances, inasmuch as the speed limit depends on the heating-up of the airframe.

Power Plant Data

11. The power plants of the new Faceplate version constitute a moderate modification of the Mikulin M-209, which is known from Tupolev's Tu-104, and bears

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the designation AM-3. The version, installed on Mig, is naturally equipped with an afterburner. The afterburning factor is very low (1.25), because the rocket engine satisfies all demands for a higher thrust. The specific consumption of AM-3, rated at 0.87 kg per 1 km/hr, is a little higher than with J-79, and increases to exactly 2 - 2.2 kg per 1 km/hr when the afterburner is cut in. These values can be considered as highly favorable. However, the powerplants are affected adversely by the relatively large weight, and the fact that the thrust decreases in direct proportion to the increase of altitude (the design precludes an adaptation by a guide-vane adjustment or a two-wave compressor). The static thrust of AM-3 is admittedly higher, but the thrust curve decreases at high altitudes with such rapidity that it is less favorable than that of J-79.

12. Adjustment of the thrust-resistance process to the requirements of a cruising flight is effected in such a manner that the cruising flight admits of the greatest range in the high subsonic zone. With the absence of an afterburner, the speed of Mig-21 is limited to the subsonic area, except for the altitude area between 8 and 15 km. With the aid of an afterburner, this aircraft is capable of attaining the speed of approximately 2,400 km/hr at the altitude of 10.5 km. This value will not increase, even under conditions of the path-angle or with the aid of rocket engine, inasmuch as the thrust of the principal powerplant is reduced sharply due to the decrement of intake efficiency.
13. The air intake is developed in the form of the Pitot intake with central diffuser bevels as a two-stroke diffuser. The efficiency almost approaches that of the lateral intakes mounted on the Supertiger.
14. The design-stipulated height of lifting surfaces made it possible to install the shock-absorber legs of landing gear laterally in the lifting surface, while the wheels are located in the fuselage. The most frequently observed high-pressure tires can be replaced, without any doubt, by low-pressure tires so as to permit the utilization of grass plots for takeoffs and landings. This mode of operation requires rocket assistance due to the length of runways. However, the shock-absorbing elements of the landing gear are dimensioned in such a manner that they can withstand the effects of shock loads.
15. Accordingly, the rate of descent in landing approach is probably very high, and the requisite resistance is produced by the brake flaps extended laterally from the fuselage stern (customary with Soviet models).

Radar and Armament

16. The radar equipment of Soviet fighter aircraft was ridiculed in the West only a short time ago. The USSR has progressed, however, in this branch of technology so as to preclude any further illusions. Without any doubt, the radar equipment of Mig-21 is fully sufficient to cope with requirements of the all-weather fighter operations. Moreover, the Soviets have in their arsenal the air-to-air guided missiles which are equal in every respect to Western counterparts. In addition, the sighting and guiding instruments of Mig-21 are adapted to firing the guided weapons. According to data not yet corroborated, the Faceplate carries under the wings four Type M-101-A missiles (standard armament for interception missions); it is possible that these missiles are equipped with infrared tracking devices. The nose section houses below semi-cylindrical fairings three Nudelmann-design guns of 20 and 37 caliber. A retractable tunnel, containing 18 non-guided rockets, is installed behind the nose-wheel section. The guided missiles can be replaced by bombs. However, the capability of carrying an A-bomb over any significant distances remains questionable.

Conclusions

17. Having subjected the flying performances and characteristics as well as areas of employability of the Mig-21 to a comprehensive scrutiny, it is

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possible to conclude with exaggeration* that it is foolish, for the time being, to attribute ultimate superiority and other superlative qualities to this aircraft.

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18. Faceplate is equivalent only in a few respects to Superfighter or Starfighter, although it is superior in one respect. The conservative high-lift devices certainly promote simplicity; however, this simplicity is acquired at an uncommonly high price by sacrifices with regard to takeoff and landing runs and the ceilings which contradict, in a drastic fashion, the valid requirements of employment.
19. The design is by no means revolutionary; in fact, it is rather conservative and precisely in those design components which do not gain anything by the conservative configuration. The consistently fascinating maximum speed is acquired through the high thrust of the engine, whose design, however, no longer yields a superior (not even a satisfactory) thrust process. The flying characteristics are convincing only within the zone of Mach 0.8 - 1.8. Adaptability to ground attack operations is likewise questionable.
20. Thus, only interception will remain as an exclusive field of employability of this aircraft; however, if the platform properties are satisfying only up to Mach 1.8, then the Faceplate already has a serious opponent in the latest US bomber, Convair B-58 Hustler, whose flying characteristics are equal to Mach 2.1 conditions.

21. Characteristics and Performance Data

Design	Mikoyan Mig21 Faceplate
Engine	1 x M 209
Static Thrust	8200 kp; 10,200 with afterburner
Crew	One

22. Dimensions

Length (Total)	17.2 m
Fuselage Length	15.3 m
Height	4.5 m
Span	10.2 m; Wing Area - 34.0 m ² ; Aspect Ratio - 3.1

23. Weights

Structural Weight plus Equipment	- 7480 kg.
Fuel	3800 kg
Crew	120 kg
Combat Load	2800 kg.
Useful load	6720 kg
Takeoff Weight	14200 kg
Landing Weight	8200 kg (max)
Wing Loading	418 kg/m ²
Thrust Loading	1.58 kg/kp
Wing Thrust	265 kp/m ²
Useful load in % of flight weight	47.5%
Combat load in % of flight weight	20.0% (Approx)

24. Performance Data

Maximum Speed at 10.5 km altitude	- Mach 2.25
Cruising Speed at 12 km altitude	- 980 km/hr
Takeoff Run up to 15 m altitude	- 1050 m.
Landing Speed	- 195 km/hr
Climbing Speed (Ground)	- 220 m/sec
Climbing Time to 10.5 km	- 2.0 min.

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Climbing Time to 16 km	- 4.8 min.
Climbing Time to 18.5 km	- 8.6 min.
Service Ceiling	- 18,500 m.
Range (Normal)	- 1550 km
Landing Run from 15 m Altitude	- 1200 m.

25. Armament

Aircraft Cannon	- 3 (Cal 20 mm and 37 mm)
Guided Missiles	- 18 (Cal 85 mm)
Other Ordnance	- Bombs

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